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SUPERCONDUCTING SUPER COLLIDER

MANAGEMENT PLAN
PHASE I

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PHASE I

This document is the management plan for the Phase I tasks of the Superconducting Super Collider (SSC) program. Phase I involves Research and Development on SSC accelerator components and systems in order to optimize performance and operating reliability with minimum fabrication and operating costs. Development and demonstration of systems reliability and manufacturability is a major goal of these activities. A Conceptual Design Report, cost estimate and construction schedule along with associated documentation will be prepared.

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CONTENTS

		Page No.
1.	Introduction	1
2.	Scope and Objectives	3
3.	Management - Organization and Responsibilities	7
4.	Project Work Plan	17
5.	Work Breakdown Structure	20
6.	Program Schedule	33
7.	Cost Estimate	37
8.	Reporting	39

SSC MANAGEMENT PLAN

1. INTRODUCTION

The purpose of this plan is to describe the management activities associated with the SSC (Superconducting Super Collider) Phase I program. This Phase I program will provide a comprehensive Conceptual Design for the SSC and will accomplish the Research and Development required prior to initiation of Construction (Phase II).

The SSC is to be a high-energy high-luminosity hadron collider similar to that described in the SSC Reference Designs Study of May 1984. The primary SSC design objectives are given in Section 2.1. The plan for assuring that the Phase I objectives are attained is detailed in the body of this document.

The major objectives of the Phase I activities are:

- To conduct the required pre-construction R&D program.
- To provide appropriate technical information and a site parameters document in support of the DOE site selection process.
- To provide a complete Conceptual Design Report/Project Proposal.
- To conduct or coordinate appropriate R&D for experimental detector systems as required.

The Conceptual Design Report will describe the technical and conventional facilities for the SSC, together with Cost, Schedule and Manpower requirements. It will also address Environmental, Safety, Quality Assurance, Operating, Reliability, and Maintainability issues.

A comprehensive Research and Development program is planned to arrive at a cost and performance optimized design, to conduct accelerator systems tests and to develop cost effective fabrication techniques. This R&D program will serve to demonstrate that the key technical features of the accelerator-collider system proposed for the SSC are achievable within the estimated cost and schedule. In addition, efforts will be directed to assess the requirements for the initial complement of detectors for the SSC physics research effort and to assess the need for R&D on advanced concepts for these detectors.

The Phase I program will provide a site parameters document and other information for DOE's site selection process. This document will be specific to those technical features of the SSC which establish requirements for the physical conditions of the site and to other factors which are important for a viable SSC facility. The SSC Phase I activity is planned to be completed by September 30, 1987. The projected cost of this program is outlined in Table 7-1.

The Phase I national effort will be carried out under the direction of the URA Central Design Group (CDG) whose Design Center is located at Lawrence Berkeley Laboratory. The CDG, working in concert with DOE, will direct and coordinate the SSC design and associated R&D activities at the Design Center, existing Laboratories and Universities, as well as at Industrial and Engineering firms. The CDG Director reports to the URA Board of Overseers, which has been specifically created for this activity. The Director will be assisted in review and decision making by senior CDG Staff and by appropriate committees.

2.0 SCOPE AND OBJECTIVES

The SSC facility as described in the Reference Designs Study (RDS) consists of a 20 TeV on 20 TeV proton-proton collider, a proton injector system, and a campus-like arrangement of buildings providing office and laboratory space, shops and other support services. The primary design goals are summarized in Table 2-1.

TABLE 2-1

PRIMARY SSC DESIGN OBJECTIVES

Proton Beam Energy (TeV/beam)	20
Design Luminosity (cm^{-2} sec^{-1})	10^{33}
Number of Interaction Regions	6

2.1 Phase I Objectives

The objectives of the SSC Phase I activity are:

- To develop the performance specifications for the Superconducting Super Collider consistent with the recommendations of HEPAP and its 1983 Subpanel on New Facilities with consideration of the results of subsequent studies and deliberations.
- To conduct SSC R&D activities, making use of the skills, experience and facilities of National Laboratories, Universities and Industry.
- To select and develop an optimum superconducting magnet design style for the SSC based upon technical, economic and other appropriate criteria.

- To develop and demonstrate techniques for cost effective production of magnets.
- To develop, as required for timely consideration in the FY88 budget process, the SSC Non-Site Specific Conceptual Design Report including cost, schedule, staffing plan, and other elements showing how the SSC can be realized in a practical, environmentally sensitive and safe manner.
- To conduct systems tests to evaluate performance reliability of magnets and other components.
- To evaluate site parameter requirements.
- To assist DOE as appropriate in site studies and to begin design of early critical path components following site selection.
- To assist as required in the development of environmental impact and safety analysis information.
- To develop a catalogue of operating needs for the SSC including utilities, cryogens, maintenance supplies and manpower levels.
- To conduct appropriate R&D activities for the development of advanced particle detectors.

2.1.1 Research and Development Objectives. A comprehensive R&D effort is required in order to develop a cost and performance optimized design for the SSC. The 1984 RDS has shown that the basic principles of design used successfully for existing accelerators can be readily extended to a proton-proton collider having the SSC primary specifications of energy and luminosity. A continuing R&D program is required to refine the cost estimates of all technical components, to verify projected technical performance, and to

develop cost-effective methods for construction and quality assurance. The major program areas and associated objectives are summarized below:

- ACCELERATOR PHYSICS. To provide input to the accelerator systems designers on such crucial issues as magnet aperture, field quality, and alignment tolerance requirements over the postulated operating range of the accelerator. For example, lattice designs with clustered Interaction Regions must be addressed as well as design concepts related to beam monitoring and control.
- SUPERCONDUCTING MAGNETS. To develop magnets that meet the aperture and field quality requirements necessary for the SSC. Additional objectives are to optimize technical performance and reduce costs of the final design. An important R&D goal will be to produce, using mass-production methods, a significant number of magnets of the chosen style. These magnets will then be thoroughly tested under conditions simulating actual collider operations.
- ACCELERATOR SYSTEMS. To demonstrate the overall performance of <u>systems</u> of magnets. Other accelerator systems R&D programs such as Refrigeration, Instrumentation and Controls, Power Supplies, Injector, Vacuum, RF and Abort will include engineering studies, modeling and prototyping in order to assure that cost effective and reliable systems are incorporated into the conceptual design.
- CONVENTIONAL SYSTEMS. To develop an efficient master plan for the facility and to find ways to minimize the cost of

conventional construction, with particular attention to tunneling technology and facility layout. The development of SSC site requirements, environmental impact information, and a site parameters document which can be used in the DOE site selection process are important components of this effort.

2.1.2 Conceptual Design Report and Other Documentation. The objectives are to develop a detailed conceptual design, a firm cost estimate, a staffing plan, and an overall construction plan and schedule. Other documentation will include draft environmental impact information, a safety analysis report, and quality assurance and quality control requirements.

3.0 MANAGEMENT - ORGANIZATION AND RESPONSIBILITIES

3.1 Organizational Relationships

The relationships among the organizational elements involved in the management of the SSC Phase I activities are shown in Figure 3-1. The programmatic responsibility for Phase I rests with the Division of High Energy Physics (DHEP) within the Office of High Energy and Nuclear Physics (HENP) in the Office of Energy Research (ER). Responsibility for contract administration and performance monitoring rests with a special SSC Team in the DOE Chicago Operations Office (CH). The contract for SSC Phase I is held by the Universities Research Association (URA), which has created a Board of Overseers to carry out its responsibility for SSC Phase I. A Central Design Group (CDG) has been created by the Board of Overseers for Phase I. The Director of the Central Design Group has been delegated the authority and assigned the responsibility to organize, plan and accomplish the objectives of the SSC Phase I. Work on tasks necessary to accomplish these objectives will be carried on by the CDG, by Laboratories and Universities and by appropriate elements of the industrial sector. Descriptions of the responsibilities of each element of the management organization are presented below.

3.1.1 The Central Design Group (CDG). The CDG is located at a Design Center at LBL. The CDG is responsible for providing direction and coordination of the approved Phase I effort. The CDG

fig 3-1

is comprised of scientists, engineers, management and administrative personnel, and others as appropriate to carry out its responsibilities. A current organizational chart is shown in Figure 3-2. The CDG is responsible for organizing, supervising, and coordinating the approved Phase I R&D work related to technical accelerator facilities and associated conventional facilities. In addition this group will be responsible for producing the SSC Conceptual Design Report and the site parameters document.

While direction and coordination of the Phase I effort rests with the CDG, much of the work will be carried out under bilateral agreements with various institutions, such as National Laboratories, Universities, and under contracts with Industrial and Engineering Firms. The CDG will develop a plan for industrial involvement in the SSC program at the earliest appropriate time, insuring that fair opportunities are provided to all interested and qualified parties.

The CDG Director will have the <u>authority</u> to exercise direction and leadership in assigning responsibilities for execution of the approved SSC program, recommending allocation of resources, developing the design of the SSC, and directing the activities of subcontractors.

The CDG Director will have the following <u>responsibilities:</u>

- Select the principal staff for the CDG.
- Prepare the Phase I Management and Program Plans, including appropriate milestones.
- Develop funding and manpower requirements for accomplishing the approved program plan.

Figure 3.2 ORGANIZATION

- Develop formal agreements with participating institutions to establish their respective responsibilities and approve the scope, resources, and milestones for each element of the R&D and design effort. Recommend to the DOE (DHEP) funding levels and allocations required to carry out the program.
- Organize, direct and manage the SSC Phase I Central Design Group and establish an agreement between the CDG and the host laboratory management for providing appropriate administrative support.
- Review and monitor performance of all SSC activities against approved milestones and plans.
- Analyze the need for additional R&D and/or the redirection, initiation or termination of activities; initiate such changes where required. Secure approval from the appropriate level of DOE for changes to the approved plan that exceed the levels given in Section 3.2.
- Evaluate cost and technical performances of participants and arrange procedures for corrective action, if required.
- Keep DOE (CH and DHEP) fully informed of program status.
- Advise the URA Board of Overseers of project status periodically and at the time of major technical decisions.
- Develop a plan for participation of the industrial sector as appropriate.

3.1.2 Department of Energy (DOE). The organizational relationships between the Office of Energy Research (ER), Office of High Energy and Nuclear Physics (HENP), Division of High Energy Physics (DHEP), and the Chicago Operations Office (CH) have been shown in Figure 3-1.

Primary programmatic responsibility for the SSC in DOE Headquarters, rests with the Director, DHEP. He is responsible for establishing SSC program requirements, for providing programmatic direction and technical overview of all SSC activities, and for providing funding allocations and programmatic guidance. He is also responsible for coordination with other DOE Headquarters Offices. In carrying out these responsibilities, DHEP shall:

- Provide Program Management and coordination of the national and international efforts related to the SSC program.
- Approve overall programmatic goals and objectives of the SSC Phase I activities.
- Approve SSC Phase I Management and Program Plans.
- Approve Primary Milestones and revisions thereto for the Program Plan.
- Approve the annual budgets for SSC activities and provide the appropriate funding allocations.
- Monitor CDG performance and other SSC activities against agreed upon Program Milestones and budget levels.
- Provide overall guidance and direction in the form of program letters.
- Conduct reviews of the SSC progress and performance.

The Chicago Operations office (CH) will provide contract administration and performance monitoring for the CDG effort. In addition, with regard to the SSC R&D management tasks, that office shall:

- o Monitor CDG performance against agreed milestones and budget levels and keep DHEP informed of any significant developments.
- o Conduct management reviews with CDG officials.
- o Recommend to DHEP changes to be made in previously approved programs and budget levels.
- o Develop and implement appropriate business and management arrangements for the execution of approved CDG activities.

3.1.3 Universities Research Association (URA). The URA activities will be carried out as a special task separate from the operation of Fermilab under Contract DE-AC02-76CH0300 administered by CH. URA has created a Board of Overseers to carry out their responsibilities for SSC Phase I. The Board of Overseers has the responsibility to appoint the Director for SSC Phase I, with the approval of DOE. The Director will serve at the pleasure of the Board of Overseers. The URA Board of Overseers will provide oversight of CDG activities.

3.1.4 Other Participants. SSC Phase I activities, including research and development, will be carried out by a variety of institutions, including National Laboratories, Universities, and Industry. The commitments made by participating organizations with regard to the agreed upon tasks, including scientific, engineering

and technical manpower, schedules, and costs, will be spelled out in individual agreements between the Central Design Group and the participating organizations. Each agreement will detail the funds and manpower required to accomplish the specified tasks and the source of funding. In some cases, the funds will be made available directly to the participant institutions from DOE through its contracts with these institutions. In other cases, funds will be made available through subcontracts with the CDG. A combination of the above two methods may be used in some instances.

The CDG will exercise control, coordination and direction of the efforts of participating institutions through the above bilateral agreements. Progress in the various R&D efforts will be monitored by the appropriate CDG Division Heads who will measure progress against the technical baselines and milestones established in the agreements.

Costs of the efforts of the participating institutions will be controlled by analysis of performance against the cost estimates established in the agreements. Variations in projected cost or schedule which exceed parameters to be established by the Director may only be authorized with the Director's approval and, where required by this Management Plan, with the approval of DOE, CH or DHEP.

Progress reports as well as complete technical reports and technical memos will be prepared by the participating institutions for review by the CDG. The technical reports will be required to be sufficiently detailed to be used in the SSC design effort and in addition they may be used to inform the scientific, technical

and industrial community of progress and accomplishments. Progress reports will normally be submitted to the CDG (with copy to DHEP) on a monthly basis. The reporting details will be negotiated as part of the bilateral agreements with CDG. Such reports would be expected to include:

- Work Title, with a summary statement of the program activities.
- Narrative description of activities (i.e. status, progress and accomplishments, problems, delays, milestones achieved, etc.).
- Budget Record (total expenditures and commitments to date, effort and procurement details).

3.2 Baselines Controls

Baselines for control will be the cost, schedule and technical system objectives presented in this document and in the bilateral agreements. The CDG will implement a management control system which will include as key elements the approved schedule, budget baseline, and work breakdown structure. Table 3-1 describes control levels and the corresponding review and approval groups.

TABLE 3-1

CONTROL LEVELS

Control Item	Deviation	Review & Recommend	Approval
	IMPACT 1		
- Primary Design Objectives	- any change	CDG & CH	DHEP
- Phase I Budget	- any change in annual funding	"	"
- Primary Milestones	- one month	"	"
- Program Milestones	- two months	"	"
	IMPACT 2		
- Phase 1 Budget	- any change* at Level 2	CDG	CH & DHEP
	- any change ≥ $500K at Level 3	CDG	CH
	IMPACT 3		
- Phase I Budget - Phase I Schedule	- any change not covered above		CDG

* Note: Any change requiring a modification of the DOE contract with a participating institution requires DHEP approval.

4.0 PROJECT WORK PLAN

In meeting the goals and objectives of the Phase I program, the CDG will provide technical direction and coordination of the efforts by National Laboratory, University, and Industrial Groups in carrying out the approved work plan. Additional details of the work to be performed are presented in Section 5.0 and in the Program Plan. The major areas of the program work are as follows:

4.1 Accelerator Physics Studies

Accelerator Physics studies will support all aspects of accelerator research, design and operation. Important tasks are lattice design and establishment of system specifications needed to assure stable and reliable operation of the SSC accelerator complex. System specifications will include the required field quality and dynamic aperture for the magnet system.

4.2 Magnet Research and Development

The development of superconducting magnet technology for the SSC involves the refinement of new magnet techniques. After the selection of a specific magnet design type, there will be an extensive design, development and demonstration effort to assure technical feasibility and reliability, cost and performance optimization, and manufacturability.

4.2.1 Superconductor Development. Superconductor development will be carried out with the goals of providing the most cost effective use of superconductor to achieve the design field for a given aperture, and arriving at an early stage at the optimum superconducting cable design.

4.2.2 Magnet Selection. The Director, with the advice of the CDG staff and of committees and individuals to be appointed by him,

will select the magnet design type to be put forward in the Conceptual Design Report. Specification of magnet tests and other technical and economic criteria which will be used as part of the magnet selection process will be provided by the Director in consultation with magnet designers, accelerator physicists and other scientists and engineers.

4.2.3 Magnet Development. Initial magnet design efforts will concentrate on model magnets, beginning with the design, construction and systematic measurement of short models and leading to the production of full-length models. Major emphasis will be on efficient use of superconductor and demonstration of the required field quality over the SSC operating range. After demonstration of the basic performance objectives, R&D studies will also focus on reliability, optimum production methods and the development of the required tooling. When sufficient prototype magnets become available, a string of magnets will be tested under simulated operating conditions.

4.3 Other Accelerator Systems

Although a major fraction of the SSC R&D is required for the superconducting magnet development, appropriate development will be focussed on other machine components. For example an important area of the vacuum system program will be the study of gas desorption from cold surfaces induced by synchrotron radiation. Other R&D areas include Refrigeration, Power Supplies, Injection Systems, Instrumentation, Controls, and Safety Systems.

4.4 Site and Conventional Facilities

The CDG, assisted by appropriate engineering firms and consultants, will prepare a Site Parameters Document, a catalogue of required

site information and other technical documents as needed to support the DOE site selection process. Also, non-site specific development of SSC conventional facility designs will be carried out for the Conceptual Design Report.

R&D on conventional facility construction, which could have a major impact on SSC cost, will be carried out where appropriate to develop a cost effective design.

4.5 SSC Conceptual Design Report

The Central Design Group, under the guidance of the Director and assisted by A/E personnel and members of the physics community at large, will prepare the Conceptual Design Report for the SSC including a firm cost estimate and construction schedule.

5.0 WORK BREAKDOWN STRUCTURE

The Research and Development Work Breakdown Structure (WBS) for the current SSC Phase I program is presented in Table 5-1. Costs will be accrued at various levels, depending upon the complexity of the system or subsystem under investigation and reported to DOE at Level 3. WBS categories may be expanded or revised during the Phase I Program in order to more efficiently monitor costs and schedules or to reflect programmatic changes that may occur in the evolution of the total SSC Research and Development effort.

The Phase I WBS presented here is not intended to represent the Phase II effort for the SSC construction and its associated cost estimate. The Phase II WBS will be presented in considerable detail in the SSC Conceptual Design Report.

The Phase I WBS defines the current SSC Research and Development effort in terms of primary tasks and organizational structure. The tasks coincide with those that have been developed in formal agreements between the CDG and other institutions. These work tasks are intimately tied to the agreed-upon budget and reporting categories for each institution and are prepared yearly to reflect the agreed-upon work scope for all participants. Thus the Phase I WBS provides a definition of the R&D work to be performed at this time as well as a mechanism for the effective monitoring and reporting of the work throughout Phase I.

Within the structure of Table 5-1, the Laboratory tasks have been developed to provide the optimum resources within the High Energy Physics program for the highest priority goals of the SSC R&D effort. The CDG serves to establish the programmatic goals and to coordinate the agreed-upon efforts within the total SSC program.

The development and optimization of superconducting magnet systems is a primary SSC activity for which defined tasks in the following section are closely coupled. For example, theoretical efforts at the CDG, LBL, FNAL and TAC all contributed to the SSC performance goals and specifications which formulate the criteria and parameters for magnet systems. For dipole fabrication, the BNL effort will provide full scale models of the "cold mass" structure. These units will be shipped to FNAL for assembly into cryostats designed and fabricated by FNAL. Systems tests of completed dipole models will take place at FNAL. At the same time LBL will provide short models that can quickly test design changes and superconductor performance. LBL will also develop models of the high gradient quadrupoles. TAC will investigate the quench protection systems that will be incorporated for the dipoles and will also develop some of the correction magnet systems that will be utilized in the spool pieces of the collider ring system. Each of the institutions thus play a major coordinated role in the total SSC R&D effort that is outlined in Table 5-1 and defined in detail in the yearly work task descriptions.

TABLE 5-1

SSC Research and Development (FY86)

1.0 SSC PHASE I PROGRAM

1.1 Central Design Group

1.1.1 Administration

1.1.1.1 Director's Office

1.1.1.2 Administrative Support

1.1.2 Program Planning and Management

1.1.3 Accelerator Research and Development

1.1.3.1 Accelerator Physics

1.1.3.2 Accelerator Systems

1.1.3.3 Superconducting Magnet Systems

1.1.3.4 Injection Systems

1.1.4 Conventional Systems

1.1.4.1 Planning and Coordination

1.1.4.2 Siting Studies

1.1.4.3 Conceptual Design

1.1.4.4 Preliminary Design

1.2 Brookhaven National Laboratory

1.2.1 Magnet Fabrication

*1.2.2 Magnet Related Systems

*1.2.3 Cryogenics and Test Support

*Ongoing Laboratory Accelerator R&D activities that are relevant to the SSC program.

TABLE 5-1 (Continued)

1.3 Fermi National Accelerator Laboratory

- 1.3.1 General
- 1.3.2 Cryostat Design and Development
- 1.3.3 Long Magnet Fabrication
- 1.3.4 Magnetic Measurements
- *1.3.5 Accelerator Theory
- *1.3.6 Half-cell Test Support
- *1.3.7 General Magnet R&D

1.4 Lawrence Berkeley Laboratory

- 1.4.1 General
- 1.4.2 Superconductor
- 1.4.3 High Gradient IR Quadrupoles
- 1.4.4 Model Magnets
- *1.4.5 Accelerator Theory

1.5 Texas Accelerator Center

- 1.5.1 Quench Protection System
- 1.5.2 Correction Magnets
- 1.5.3 Accelerator Physics
- 1.5.4 Superferric Magnet Test Completion

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*Ongoing Laboratory Accelerator R&D activities that are relevant to the SSC program.

WBS Task Descriptions

The tasks to be performed under each element of Table 5-1 are described below.

1.1 THE CENTRAL DESIGN GROUP

1.1.1 Administration

1.1.1.1 Director's Office

Provides for overall scientific management, direction and coordination of the SSC program. Efforts involve direction of design work, coordination of the various laboratory programs with the CDG activities as well as that of University Groups and Industrial Firms. This office is the focal point for contact with DOE and URA. Included are SSC Director and Deputy Directors together with scientific advisors and consulting groups.

1.1.1.2 Administrative Support

Provides personnel administration and personnel support for CDG activities. Provides all office services including secretarial support and travel and housing service and coordination.

1.1.2 Program Planning and Management (Division)

Provides for overall operations management in terms of research planning and associated budget projections for the R&D program including coordination of Laboratory efforts. Covers efforts for reporting, and documentation of the SSC program. A major responsibility is the construction planning, cost estimating and cost analysis required for the SSC Conceptual Design.

1.1.3 Accelerator Research and Development

1.1.3.1 Accelerator Physics (Division)

Provides theoretical accelerator studies as required for the SSC design. The Division coordinates accelerator physics activities at CDG with work at laboratories and universities.

Specifics include detailed calculations and studies of aperture requirements and required magnetic field quality of storage rings, detailed understanding of beam instabilities, and development of injection methods. Overall SSC performance parameters are verified through computations and simulations of accelerator systems.

1.1.3.2 Accelerator Systems (Division)

Provides for R&D activities on accelerator systems including power supplies, R.F., controls, injection and abort, magnet correction elements and cryogenic systems. Of primary importance is the systems integration of all accelerator components. Detailed considerations are given to systems design and its relation and impact on accelerator operations. Detailed operations goals and requirements including beam safety systems are important aspects of this activity.

1.1.3.3 Magnet Systems (Division)

Provides for the direction and coordination of magnet R&D activities at the various accelerator laboratories. This program coordinates the engineering and development activities for the selected magnet design. In general this Division has responsibility for providing a cost effective magnet design of the required field quality together with a detailed understanding of operational efficiency, reliability, and safety requirements.

1.1.3.4 Injection Systems (Division)

Activities include the determination of a complex of booster accelerators to provide the optimum injection system for the SSC storage ring. Overall requirements will be established and design concepts will be developed by this Division.

1.1.4 Conventional Systems (Division)

1.1.4.1 Planning and Coordination

Includes determining the site related requirements of the SSC. The work consists of examining the technical needs for the conventional facilities with regard to civil, mechanical, and electrical systems. The services of experienced Engineering firms will be utilized in conjunction with the efforts of this CDG Division to provide detailed construction plans and cost estimates. The coordination of all the SSC work on site and conventional systems will be under this Division.

1.1.4.2 Siting Studies

The siting studies will develop the following information:

1. A technical description of the SSC.
2. Tables of SSC parameters.
3. Limits or ranges of the site criteria data.
4. Information needed about proposed sites.

1.1.4.3 Conceptual Design

This activity will provide a Conceptual Design for Conventional Systems in early 1986. Considerable technical work is required to incorporate the accelerator systems that are being designed, so that efficient and cost-effective solutions can be found for the

projected laboratory facilities. The Reference Design plan will be extended including schedules and cost estimates together with a master plan for effective research use of the proposed facility.

1.1.4.4 Preliminary Design

This activity will adapt the Conceptual Design to the features of real sites being considered by the DOE. Upon selection of a site, specific technical and survey information will be incorporated into a pre-title I design. This will provide the basis for optimization studies to generate the most cost effective design.

1.2 BROOKHAVEN NATIONAL LABORATORY (BNL)

1.2.1 Magnet Fabrication

This category encompasses engineering, design, fabrication, and testing of components and subsystems of the SSC main ring dipoles. Six complete full scale (16.6 m) cold mass assemblies are to be fabricated in FY86. Engineering associated with integration of the dipoles with the rest of the magnet system is included.

1.2.2 Magnet Related Systems

This program area includes collar design optimization, magnet end and interconnection design and development, engineering studies of strain gauge measurements on model magnets, coil and iron cross section optimization studies, development of straight ends for main coils, and the development of appropriate magnetic measurement systems.

1.2.3 Cryogenic and Test Support

Provides cryogenic analysis and systems support for dipole magnetic measurements as well as overall studies for cryogenic systems concepts, design features, test facilities, and cost optimization.

1.3 FERMI NATIONAL ACCELERATOR LABORATORY (FNAL)

1.3.1 General

Includes general support activities and the preparation of detailed technical reports in all categories. The drawings and specifications for magnet systems integration are part of this activity.

1.3.2 Cryostat Design and Development

This activity includes mechanical and thermal characterization of the cold mass system, development of the magnet suspension system, and the overall cryostat design. Magnet interconnections, alignment studies, and shipping/handling requirements are included in this development.

1.3.3 Long Magnet Fabrication

This work involves cryostat fabrication and magnet assembly. One model cryostat will be assembled for first tests without magnetic elements. Then four complete (16.6 m) dipole systems will be assembled with single phase assemblies provided by BNL.

1.3.4 Magnetic Measurements

Included are modifications of the magnet test facilities to individually test and measure completed dipoles. Four complete dipole units are planned to be tested per approval protocol in FY86.

1.3.5 Accelerator Theory

Provides for calculations and analysis of scientific tasks relevant to the SSC conceptual design. Tasks include the establishment of parameters and the analysis of beam requirements appropriate to a system of accelerators for the SSC Injection System.

1.3.6 Half-cell Test Support

Provides for the half-cell (5 dipoles) mechanical, cryogenic, electrical, and magnetic tests.

1.3.7 General Magnet R&D

Includes the development of a passive low field correction system, low current cable for correction elements, and the design and development of other special magnets.

1.4 LAWRENCE BERKELEY LABORATORY (LBL)

1.4.1 General

Provides for support activities necessary for the LBL SSC program such as administration, program coordination, general purpose materials, and detailed technical reports.

1.4.2 Superconductor

LBL has the responsibility for procuring the cable for the 1-m model programs and the six full length (16.6 m) dipole units to be fabricated at BNL. This task includes preparation of specifications, procurement, and tests. Cabling improvements will also be developed and evaluated for the overall SSC Program.

1.4.3 High Gradient Interaction Region Quadrupoles

LBL will develop and optimize a magnetic design for the high gradient IR quadrupoles. Construction and tests of a 1-m model to verify performance will be carried out.

1.4.4 Model Magnets

LBL will design, fabricate, and test a series of 1-m models to optimize the field quality for the full scale dipoles. The model program will also serve to confirm field reproducibility of designs as affected by fabrication tolerances and other design features.

1.4.5 Accelerator Theory

Includes programmatic support for the overall SSC lattice design, aperture specifications, and magnetic field tolerances as well as accelerator systems specifications and analysis as required for the CDR.

1.5 TEXAS ACCELERATOR CENTER (TAC)

1.5.1 Quench Protection System

TAC will assess the critical parameters and define the system requirements. Experiments will be carried out to verify existing data and prepare for a comprehensive diode test program geared to optimize the SSC systems design for reliable operations.

1.5.2 Correction Magnets

Provides for correction element conceptual design, description, and cost estimates required for the CDR. Design features of dipole and quadrupole elements will be developed. A model dipole corrector will be fabricated and tested.

1.5.3 Accelerator Physics

Includes beam dynamics studies as well as systems design and performance studies in support of the CDG accelerator physics program.

1.5.4 Superferric Magnet Test Completion

Includes tests and measurements of existing 1-m model magnets at TAC and two 28-m models fabricated by General Dynamics. Provides documentation for conclusion of the SSC Superferric Magnet Program..

6.0 PROGRAM SCHEDULE

The major program elements for the SSC Phase I effort are summarized below. The details of this program have been described in Section 5. The associated program milestones are tabulated in Table 6-1. The program schedule is outlined in Fig. 6-1.

The Theory Group activities are a critical part of the early R&D program. In conjunction with studies of beam limitations (instabilities, etc) and performance, one of the most important tasks is the determination of the optimum lattice system and the required aperture for the storage ring. Work will be directed toward optimizing all accelerator systems parameters, including the injector. The Injection System Group will then study a number of possible injections schemes. The appropriate system will be optimized with respect to projected performance and reliability.

One of the many tasks of the Accelerator Systems Group is to provide detailed information regarding accelerator operations requirements. An important aspect of this work will be the planning and execution of the tests of systems of magnets (string test). Also, work will be directed to studies of cryogenics, vacuum, power supplies, R.F. systems, beam instrumentation, and control systems in preparation for the CDR. Prototype tests of developmental components will be conducted in FY86 and FY87.

Development programs for superconducting magnets are in progress at BNL, LBL, FNAL and TAC. Program coordination is achieved through the SSC Magnet Systems Group. Efforts are now focussed on a single design style. The R&D program will seek to optimize the technical performance of this design as well as the fabrication techniques. An intense

development program is planned with fabrication of a number of prototype magnets. These units will be thoroughly tested in a system which closely simulates actual operating conditions. The system tests are projected to begin at the start of FY87.

One of the first tasks of the Conventional Systems Group was to develop a site parameters document for the SSC. This first major SSC milestone was completed on schedule in April 1985. Current efforts are being directed toward preparation of the Conceptual Design Report. The selection of an engineering firm to assist these activities has been completed. Beyond the CDR effort the start of Title I is planned in order to help provide an orderly and efficient construction start.

The program schedule is geared to a construction start in FY 1988. The projected costs for the overall program are provided in the next section.

TABLE 6-1

PHASE I PROGRAM MILESTONES

Date		Item
Oct 1984		Define Selection Criteria and Technical Information needed for Magnet Selection
Nov 1984		Established Primary SSC Design Features and SSC Phase I Program Plan Objectives
Apr 1985	*	Site Parameters Document
Apr 1985		Review Magnet Development Program
Sep 1985	*	Magnet Design Type Selection
Dec 1985		Preliminary Conceptual Design
Feb 1986		Start Pre-Production Prototype Magnets
Mar 1986	*	Conceptual Design Report (non-site specific) and Other Documentation
June 1986		First Full-Length Magnet Test
Sept 1986		Start Magnet Technology Transfer to Industry
Oct 1986		Start Magnet Systems Test
Aug 1987		Recommended SSC Phase II Management Plan
Oct 1987	*	SSC Construction Start (NTP)
Nov 1987		First Full Length Industry-produced Magnet Model

* Denotes Primary Milestone

table

7. COST ESTIMATE

The cost projections for Phase I activities through FY87 are provided in Table 7-1. The projections indicated represent the costs required for necessary staffing levels, equipment support, materials and component purchases, and relevant fabrications. The cost estimates reflect the scope and schedule accomplishments that each R&D activity needs for overall program goals. The specifics of this cost estimate may change as details of the R&D program evolve together with actual annual budgets. The program plan will be updated to reflect these conditions as required.

TABLE 7-1

SUPERCONDUCTING SUPER COLLIDER
PROJECTED R&D COSTS - PHASE I (M$)

CDG	FY85	FY86	FY87*
Adm/Plan/Support	2.1	3.3	3.9
Accelerator Physics	1.0	1.5	1.6
Conventional Systems	1.1	2.6	3.3
Purchased Engineering Serv.	(.83)	(2.0)	(2.5)
Injector	0.1	0.2	0.4
Magnets	0.5	1.1	9.3**
Accelerator Systems	0.5	1.3	1.5
CDG Subtotal	5.3	10.0	20.0
LABS			
Accelerator Systems	0.7	1.5	2.0
Magnet Systems Tests	--	1.3	2.5
Magnet Program	14.0	7.2	7.5
Lab Subtotal	14.7	10.0	12.0
TOTAL SSC OPERATIONS	20.0	20.0	32.0
TOTAL SSC EQUIPMENT	0.5	0.8	1.5

* CDG Request
** Includes Industry Magnet Program

8. REPORTING

The SSC project will document its research efforts, by means of publications, technical reports, and technical memos. Such reports will be published or distributed by the CDG with appropriate distribution lists.

Progress reports by SSC participants to the CDG director have been described in Section 3.1.4. Such reports will provide the required information which will be utilized in the Project Progress Reports.

The CDG will provide appropriate monthly progress reports to DOE (CH & DHEP) and to URA. These reports will describe the technical activities of the SSC Phase I effort together with the related budget details. These reports are expected to contain the following format and information:

- Project Summary
  - Narrative (highlights)
  - Major Milestones
- Project Report (for each WBS Level III)
  - Participants
  - Location(s)
  - Narrative
    (information to include status, progress, problems, etc.)
  - Cost & Schedule Data

The DOE will conduct a comprehensive annual review of the entire project at the Central Design Center. This review will be scheduled and organized by DHEP and may include the use of outside technical experts.

The DOE will also conduct quarterly reviews of the SSC effort. These reviews, which will be conducted three times between the annual reviews, will be scheduled by CH and include participation of DHEP staff.